

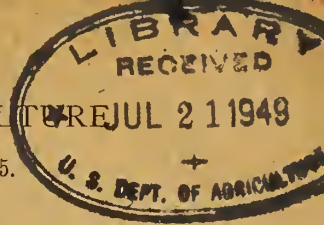
Historic, archived document

Do not assume content reflects current
scientific knowledge, policies, or practices.

1
F76B
p. 3
U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF FORESTRY—BULLETIN No. 45.

GIFFORD PINCHOT, Forester.

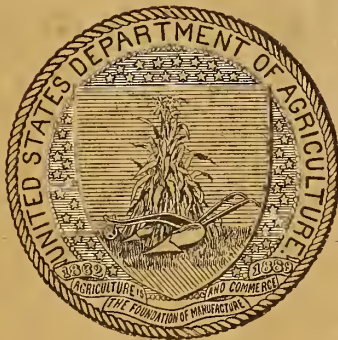


REYNOLDS LIBRARY
THE PLANTING OF WHITE PINE
IN NEW ENGLAND.

BY

HAROLD B. KEMPTON,

Field Assistant, Bureau of Forestry.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

BUREAU OF FORESTRY.

GIFFORD PINCHOT, *Forester.*

FOREST MEASUREMENTS,

OVERTON W. PRICE, *in Charge.*

FOREST MANAGEMENT,

THOMAS H. SHERRARD, *in Charge.*

DENDROLOGY,

GEORGE B. SUDWORTH, *in Charge.*

FOREST EXTENSION,

WILLIAM L. HALL, *in Charge.*

FOREST PRODUCTS,

HERMANN VON SCHRENK, *in Charge.*

RECORDS,

JAMES B. ADAMS, *in Charge.*



PLANTED WHITE PINE, 43 YEARS OLD.

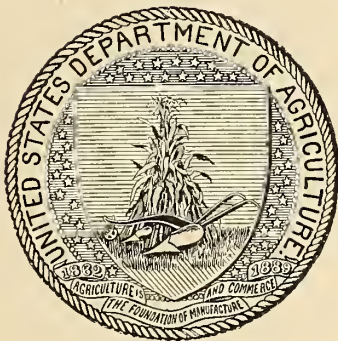
U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY—BULLETIN No. 45.

GIFFORD PINCHOT, Forester.

THE PLANTING OF WHITE PINE
IN NEW ENGLAND.

BY

HAROLD B. KEMPTON,
Field Assistant, Bureau of Forestry.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF FORESTRY,

Washington, D. C., June 29, 1903.

SIR: I have the honor to transmit herewith a report entitled "The Planting of White Pine in New England," by Harold B. Kempton, field assistant in the Bureau of Forestry, and to recommend its publication as Bulletin No. 45 of the Bureau of Forestry.

The thirteen plates and two text figures accompanying this bulletin are necessary for its proper illustration.

Very respectfully,

GIFFORD PINCHOT,

Forester.

Hon. JAMES WILSON,

Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
White pine planting commercially feasible.....	7
Range for planting.....	7
Where planting is advantageous.....	7
Watershed planting	7
Planting on sand barrens and seaside dunes.....	8
Planting on bare lands and worn-out pastures.....	9
Planting on cut-over lands.....	9
The woodlot.....	9
Early methods.....	10
Investigations in white pine plantations.....	11
Plantation of Mr. H. G. Russell, East Greenwich, R. I.....	12
History.....	12
Objects.....	12
Effect of sea winds.....	13
Measurements	13
Important facts illustrated.....	18
Planted forest of Mr. Isaac Adams, Moultonboro, N. H.....	18
Location.....	18
Objects.....	19
History.....	19
Condition of the forest.....	19
Measurements	20
Important facts illustrated in the Adams plantation.....	23
Plantation of Mrs. Frederick Brunson, Greenfield Hill, Conn.....	24
Condition of the forest.....	24
Growth.....	24
Measurements	25
Important facts illustrated in the Brunson plantation.....	26
A representative planted white pine woodlot.....	26
History.....	26
Condition	26
Measurements	26
Growth.....	27
Mixtures used and their comparative value.....	29
European larch.....	29
Oaks	29
Chestnut	30
Scotch pine.....	30
Red pine	30
Norway spruce.....	31
Sugar maple	31

	Page.
Starting a white pine plantation	31
Seed and seed years	31
Collecting and storing seed	32
Preparation of seed bed, sowing, and shading	33
The plantation	35
Transplanting	36
Treatment after planting	38
Pruning	38
Thinning	39
Age for profitable lumbering—cost and profit	39
Initial outlay per acre	40
Returns	40

ILLUSTRATIONS

PLATES.

	Page.
PLATE I. Planted white pine, 43 years old.....	Frontispiece
II. White pine plantations. Fig. 1—Plantation on rocky soil near Bridge-water, Mass. Fig. 2—Plantation on almost pure sand, East Greenwich, R. I.....	8
III. Interior of plantation in exposed situation on Narragansett Bay.....	8
IV. A seed spot in the forest.....	16
V. Fig. 1—White pine weevil at work in terminal shoot. Fig. 2—Good recovery after an attack of white pine weevil.....	16
VI. Fig. 1—A 3-year-old nursery-grown seedling after being two years planted in the forest. Fig. 2—Young white pine, two years after being set in a mature forest, showing mulch of oak and chestnut leaves.....	20
VII. Terminal shoot of white pine, showing excellent growth and seed production.....	20
VIII. A good seedbed for natural reproduction.....	24
IX. Two white pines, each 9 years old.....	24
X. Artificial seedbed with movable shades.....	28
XI. Soil of suitable character for first-rate growth of white pine.....	28
XII. Two-year-old white pine seedlings.....	32
XIII. Fig. 1—A poorly pruned tree. Fig. 2—Same tree well pruned.....	32

TEXT FIGURES.

FIG. 1. Marker for seedbed.....	34
2. Shade for seedbed.....	35

THE PLANTING OF WHITE PINE IN NEW ENGLAND.

INTRODUCTION.

WHITE PINE PLANTING COMMERCIALLY FEASIBLE.

Destructive methods of lumbering, forest fires, and the inability of white pine to reproduce in the intense shade of broadleaf trees have obliterated the great white pine forests of the East. Immense areas of land formerly clothed with the richest forest are now barren wastes, or are covered with comparatively worthless woods. The increasing value of lumber and the worthlessness of a great part of this forest land for other purposes make the restoration of these forests an important economic consideration. A study of planted white pine in New England shows planting to be practical not only for States and corporations, but for the private landowner as well.

RANGE FOR PLANTING.

The range for the planting of white pine in the United States is from Maine to the Dakotas, and south to the Missouri and Ohio rivers and southern Pennsylvania, and in the Appalachian Mountains to Alabama and Georgia. It may in some cases be carried beyond these limits to parts of Virginia, Maryland, Delaware, New Jersey, Ohio, Indiana, Illinois, Iowa, Missouri, and eastern Kansas and Nebraska. White pine is especially suited for planting on the cleared and cut-over areas of New England, New York, Pennsylvania, New Jersey, Virginia, and the Appalachian Mountain region.

WHERE PLANTING IS ADVANTAGEOUS.

White pine may at present be advantageously used for planting on watersheds, on sand barrens and seaside dunes, on bare lands and worn-out pastures, on cut-over land, and for woodlots.

WATERSHED PLANTING.

Many large towns and cities store their water supply in lakes or reservoirs, which collect and hold the surface drainage water. When the streams upon which they depend have bare watersheds, they flow in torrents and are wasted in the spring, but soon become exhausted

in time of drought. As a result, there is likely to follow not only a water famine, but also an epidemic of disease, the germs of which find perfect conditions for development in the stagnant pools that are left by the shrunken streams. After the first heavy rain they are washed into the reservoir below, contaminating the entire supply.

Whenever natural reproduction can not be depended upon to cover the pastures and bare lands of reservoir watersheds with forest growth, they should be planted, with the immediate object of protection and the ultimate purpose of lumbering. Figures can now be produced which show that forestry thus practiced is profitable. It therefore becomes a problem which deserves the careful consideration of every water company having waste or idle lands. Forests on the watershed purify the water, regulate the flow, prevent erosion and hence turbidity, and cool and shade the streams, besides converting the lands into attractive woodland, which can eventually be lumbered at a profit on the whole investment.

An example of practical watershed planting on a large scale may be found at Clinton, Mass., where the Metropolitan Water and Sewerage Board, which supplies Boston and many surrounding cities with water, is planting 1,500 acres to white pine and sugar maple in mixture, under plans prepared by the Bureau of Forestry. The planting will be done on the old farms, pastures, and bare waste lands upon the watershed of its immense reservoir. Areas which already contain forest trees will be managed to produce a valuable crop from the natural growth.

In New Haven, Conn., the water table has been completely cleansed and is being treated for the production of forest both by natural reproduction and by planting.

PLANTING ON SAND BARRENS AND SEASIDE DUNES.

In Connecticut, Rhode Island, New Hampshire, Massachusetts, and other Eastern States, there are considerable areas of barren sand plains, which at present are a source of expense to their owners. It is not practicable to farm them, as there is not sufficient humus in the soil to support a crop, and fertilizers would wash out with the first heavy rain.

It has been shown in a plantation at Shakers, Conn., that these sandy lands will support a good growth of white pine. Established in pure, drifting sand, this plantation has made an average annual height growth of 1.44 feet per year from the time when 4-inch to 6-inch seedlings were planted, twenty-five years ago, up to the present, when the plantation averages 36 feet in height. This height growth, even though in sand, is greater than the average height growth of planted white pine in the East, which at 25 years of age is only 32 feet. Such instances prove that planting may be practiced here with as good returns as on many of the more valuable soils.



FIG. 1.—PLANTATION ON ROCKY SOIL NEAR BRIDGEWATER, MASS.



FIG. 2.—PLANTATION ON ALMOST PURE SAND, EAST GREENWICH, R. I.

WHITE PINE PLANTATIONS.



INTERIOR OF PLANTATION IN EXPOSED SITUATION ON NARRAGANSETT BAY. (FARM OF H. G. RUSSELL.)



Often the problem is not one of purely commercial planting, but of preventing drifting sand from encroaching on valuable property. Near the coast the white pine is not the best tree for this use, owing to the injurious effect of salt winds upon its foliage. But for the interior sandy lands of the Northeast no better tree can be recommended.

PLANTING ON BARE LANDS AND WORN-OUT PASTURES.

There is a large amount of land in New England which, though practically worthless for other purposes, shows favorable conditions for forest planting. In many regions, especially in Massachusetts, Connecticut, and New Hampshire, these bare lands are slowly being covered naturally with white pine. This growth in most cases will never be of much value because, standing as it does in the open, it is low, branching, and undesirable. The expense of planting on these lands is comparatively low, for 2-year-old seedlings may be planted, whereas on sprout or brushy areas it is usually found necessary to use transplants. The cost of planting is thus reduced about 50 per cent.

PLANTING ON CUT-OVER LANDS.

In almost every Eastern State there are large areas of forest land which have been cut over, and have since been swept by annual fires which have driven out the valuable species, and left scrubby oak, cherry, maple, poplar, and shrubs. Such land presents one of the most difficult of tree-planting problems, and usually planting is impracticable upon it. Much additional care and expense is necessary to protect the young seedlings from fire and the competition of rapid-growing trees and shrubs. The expense of planting also is increased, for all dense sprout growth must be removed and larger seedlings or transplants used in order to advance the growth as much as possible.

On recently cut-over areas which have not been burned, tree planting is seldom necessary, for usually valuable species will reproduce naturally. Cut-over recently burned areas frequently present satisfactory conditions, and planting of 3-year-old once-transplanted white pine should be successful. On areas where sprout growth is scarce or poorly distributed practical tree planting usually consists merely of filling the gaps, thus assisting natural regeneration.

THE WOODLOT.

On almost every farm there are at least a few acres which are valueless for other purposes than woods, and which might produce fuel, fence-posts, and timber for the construction of farm buildings. The farmer need be at little expense in planting these tracts, for usually he can collect his own seed or seedlings. If his land is unsuitable for direct seed planting, he may either gather his seedlings in the

forest or grow them in his own nursery. The value of such a woodlot for the farm is not restricted to the actual amount of posts, fuel, or timber which it may produce. Frequently in New England the cause of failure in orchards and various other perennial crops is the lack of snow protection about the roots during winter. A combined woodlot and windbreak from one to several rods in width, extending about the orchard or garden, will gather snow evenly over the inclosure. Thus protection is afforded where otherwise the wind would sweep the land, piling the snow in heaps about the fences, roads, and buildings.

EARLY METHODS.

Between the years 1820 and 1880 was a period of enthusiastic white pine planting in New England. Men were then able to foresee the time when the marketable native white pine would be gone and the rise in prices would make the planted timber of economic importance. Those owning lands covered by shifting sand began to realize that their property might be put to profitable use in forest production. Large plantations were made by private owners, and some few by corporations. At the end of this period there were said to be in Massachusetts alone forest plantations of white pine to the extent of over 10,000 acres. About 1880 the interest began to decline, largely because it was found possible to bring lumber from the immense supply in the region of the Great Lakes at a lower transportation rate than had been expected, and until the past few years little other planting was done.

In the early planting it was almost always the hope of the planter to reap eventually a crop of lumber from his forest plot, but usually this was a secondary consideration. The main object in establishing the grove was to beautify grounds, protect them from the winds, and eventually to secure posts, fuel, or other timber.

The methods used during the first period varied greatly in different places, for little was known in this country about practical forest planting. The initial outlay was frequently so great that when the interest on the investment is considered the planting proved to be very unprofitable. In most cases it was done by men of considerable wealth, who desired to establish a forest as quickly as possible. They therefore bought trees which had been several times transplanted and which were 8 to 20 inches high. Such trees usually cost not less than \$10 per 1,000. Counting about 2,000 trees to the acre, which was the average number used, the outlay for seedlings alone is \$20 per acre. Compound interest at 5 per cent during the period of growth brings this single item of expense to not less than \$80 per acre for mature trees. Adding to this taxes and other expenses, the commercial impracticability of such planting is readily seen.

In some instances the first outlay was small, and it is these plantations

which now prove that white pine can be planted in New England at a profit.

In a few cases successful seeding has been practiced. The seed was sometimes sown broadcast and sometimes in prepared spots. (See Pl. III.) It has frequently proved successful where practiced on rather bare areas or on pastures under conditions which favor natural reproduction. At Bridgewater, Mass., Hon. Augustus Pratt fifty years ago planted an old pasture to white pine seed. The crop was sold on the stump several years ago for \$160 per acre, and was lumbered for box boards. On the other hand, many failures have resulted from experiments in broadcast sowing of white pine seed. In all recorded cases it has been unsuccessful on cut-over lands having a heavy sprout growth.

INVESTIGATIONS IN WHITE PINE PLANTATIONS.

During the summer of 1901 careful surveys were made in the most important white pine plantations of the East. The main object of this examination was to determine the advisability of white pine planting as a practical investment. Measurements were made in plantations varying in age from 11 to 48 years. The investigation included the diameter and height measurement of 98,995 trees in Massachusetts, New Hampshire, Rhode Island, Connecticut, and Virginia to determine the volume increment. Measurements of the annual growth were also made to learn the rate of height growth of white pine, both planted and native, for each separate year from the seedling stage. In addition, similar measurements were made on several other conifers which were found in mixture with the white pine. In the older plantations reproduction was studied and counts were made to determine the number of seedlings per acre. Measurements were also made of trees on the border of plantations in order to compare them with those in the interior. The effects of the white pine weevil on the growth of the tree were carefully studied.

The following plantations were examined:

East Greenwich, R. I., 150 acres of white pine, European larch, white oak, Norway spruce, and other species, owned by Mr. H. G. Russell.

Woods Hole, Mass., 200 acres of white pine, pitch pine, and red fir ("Douglas spruce"), owned by the Joshua S. Fay estate.

North Beverly, Mass., 75 acres of white pine and red fir, owned by Mr. John C. Phillips.

Manchester, N. H., 150 acres of white pine, owned by Hon. Gordon Woodbury.

Enfield, Conn., 150 acres of white pine on sand plains, owned by Mr. Omar Pease.

Olivers Mills, Pa., 1,200 acres of white pine, owned by Gen. Paul A. Oliver.

Greenfield Hill, Conn., 30 acres of white pine and European larch, owned by Mrs. Frederick Brunson.

Moultonboro, N. H., 75 acres of white pine, owned by Mr. Isaac Adams.

Bridgewater, Mass., 50 acres of white pine, owned by Mr. George Wilbur, and 30 acres of white pine, owned by Hon. Augustus Pratt.

South Orleans, Mass., 40 acres of white pine, owned by Mr. John Kendrick.

Monaskon, Va., 300 acres of catalpa, chestnut, white pine, locust, etc., owned by Mr. Burnet Landreth.

All of these plantations are more than 15 years old, except that of Gen. Paul A. Oliver, which has been planted within the last five years.

The plantations here considered are among the most important in the East, and present features of peculiar interest in a study of the growth of white pine under various conditions.

PLANTATION OF MR. H. G. RUSSELL, EAST GREENWICH, R. I.

HISTORY.

The estate of Mr. Russell lies across the cove from East Greenwich, Kent County, R. I., at the head of Greenwich Bay. The forested part of the estate consists of 150 acres of flat or gently undulating sandy stretches of land lying along the shore. Twenty-seven years ago a large portion of this was bare drifting sand, in places covered with scattered cedar and scrub oak. A strip 8 to 20 rods wide and several miles long has been planted to forest trees, with the result that instead of a desolate waste there is now a beautiful forest park. The forest extends to the cliff on the south shore of Greenwich Bay and cove, and is in a most exposed situation, facing north and east.

In 1877 the work was begun by planting several acres with white pine, once-transplanted stock, which cost \$4.50 per 1,000. Between 1877 and 1894 there were planted 150 acres to white, red, Scotch, and Austrian pines, European larch, white and Norway spruces, red fir, hardy catalpa, white, red, pin, and scarlet oaks, and ailanthus. A large area was planted to 6-inch white pine seedlings, 1,200 to the acre, which cost \$6 per 1,000, or \$7.20 per acre. The planting raised the cost to about \$10. The greater outlay required for seedlings of this size was justified by the fact that the object was primarily to secure protection and embellishment of the property, the eventual profit from lumbering being a secondary consideration. (See Pl. II, fig. 2, and Pl. III.)

OBJECTS.

The objects of Mr. Russell in planting were:

(1) To seclude his grounds from the town of East Greenwich, which lies just across the cove.

(2) To protect his buildings from the strong, cold winds from the north, northwest, and northeast.

(3) To hold the sand.

(4) To afford fuel and fence posts for use on the estate.

(5) To improve the estate and to form a forest park.

(6) To offer for the public benefit an illustration of what tree planting would accomplish in an exposed position where the soil is of little value for other crops.

Mr. Russell has not, therefore, treated his plantation wholly as an economic investment. That good boles might be formed, the larger trees have been pruned and the plantation has been thinned until on the greater portion the trees now stand 12 by 12 feet, instead of the original 6 by 6 feet.

EFFECT OF SEA WINDS.

It is interesting to note the effect on the border trees to seaward of the plantation of the sea winds from Narragansett Bay, which it was feared would injure the white pine. Although the branches persist almost to the ground, they are gnarled and crooked. The trees bend landward strikingly, showing their antipathy to the cold salt winds. This effect, however, does not extend to the interior, except where some more vigorous tree, forcing its shoot above the rest, has been bent almost at right angles to the stem by the hard, cold, damp winds. The wind influence was much modified in places by a natural growth of oak, cedar, pitch pine, locust, and birch which grows along the side of the ledge, separating the plantation from the beach.

MEASUREMENTS.

In this white pine plantation more than 10,200 measurements were made for the purpose of determining the rate of growth. The results are shown in the tables given below.

The tables present data from trees twelve to twenty-three years planted, and fairly represent what may be expected of a white pine forest on sandy land and in an exposed position. The height is below the normal, mainly because of damage from weevils; but this damage is now being overcome, as for the last ten years little injury has been done.

The trees have been classified according to height growth, those measuring between 9.5 and 10.5 feet high appearing in the tables under the 10-foot class, those between 10.5 and 11.5 feet under the 11-foot class, etc. The tables are arranged in three divisions, which comprise all the trees on a given area. Division I includes the trees which are especially backward, either because of suppression or because dwarfed in consequence of some injury; Division III those which, owing to their peculiar vigor or exemption from external inter-

ference, have grown especially fast and have become dominant; Division II includes the main bulk of the forest. The trees in this division have all made steady and determined growth from the start, though by no means equal growth, as the table shows, for they range from 12 to 19 feet in height, and so include many trees which will soon be dominant, and many others which are plainly destined to be suppressed. The divisions therefore do not correspond closely with that frequently adopted into dominant, subdominant, and suppressed; they are employed rather to distinguish between the body of the forest on the one hand and on the other the exceptional individuals which are conspicuously leading or conspicuously lagging behind.

TABLE 1.—*Growth of planted white pine, East Greenwich, R. I.*

PLANTATION OF H. G. RUSSELL.

[Based on 306 trees 12 years planted.]

Division.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
		<i>Feet.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>Inch.</i>
I.....	6	10	1.7	0.8	0.14
	4	11	1.6	.9	.13
	28	12	2.2	1.0	.18
	39	13	2.6	1.1	.22
II.....	48	14	3.1	1.2	.26
	53	15	3.2	1.3	.27
	38	16	3.5	1.3	.29
	34	17	3.8	1.4	.32
	19	18	4.3	1.5	.36
	12	19	4.4	1.6	.37
	8	20	4.3	1.7	.36
	6	21	5.0	1.8	.42
III.....	8	22	4.8	1.8	.40
	2	23	4.8	1.9	.40
	1	24	5.0	2.0	.42

Only 3 per cent of the trees are in Division I. They have made a growth of only 0.8 foot in height per year, and 0.13 inch in diameter. These trees are more distinct from the others than is usual. Thus, while Division I shows only 0.13 inch per year as diameter increase, and a height growth of less than a foot, the second class shows a growth in diameter of from 0.18 to 0.37 inch per year, and a height growth of 1 to 1½ feet as the average. Division II in large measure represents the portion of this grove which has been attacked once or more by the white pine weevil.^a It includes 92 per cent of all the trees, varying

^aThe Division of Entomology of the United States Department of Agriculture is now conducting special investigations of the white pine weevil, the results of which, together with recommendations for controlling the insect, will be embodied in a bulletin soon to be issued.

in height from 12 to 19 feet. Division III represents trees which have been unaffected by damaging influences. It contains 5 per cent of the trees, and they have made an average height growth of from 1.5 to 2 feet, and diameter growth of 0.36 to 0.42 inch per year.

The soil is sandy, but is gradually improving in its condition. The trees still retain all their lower branches, which are quite large, owing to the rather wide spacing (8 by 8 feet). Seed production has begun, but as yet has been light.

TABLE 2.—*Growth of planted white pine, East Greenwich, R. I.*

PLANTATION OF H. G. RUSSELL.

[Based on 793 trees 15 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
15	11	2.3	0.7	0.15	68	19	5.2	1.3	.35
20	12	2.7	.8	.18	62	20	5.5	1.3	.37
51	13	2.7	.9	.18	74	21	5.6	1.4	.37
72	14	3.4	.9	.23	41	22	6.1	1.5	.41
75	15	4.1	1.0	.27	23	23	6.2	1.5	.41
85	16	4.3	1.1	.29	9	24	5.8	1.6	.39
112	17	4.5	1.1	.30	1	25	7.0	1.7	.47
85	18	5.0	1.2	.33					

TABLE 3.—*Growth of planted red pine, East Greenwich, R. I.*

PLANTATION OF H. G. RUSSELL.

[Based on 142 trees 15 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
22	12	2.8	0.8	0.19	3	20	6.0	1.3	.40
14	13	3.2	.9	.21	14	21	6.1	1.4	.41
13	14	4.2	.9	.28	6	22	6.9	1.5	.46
16	15	4.4	1.0	.29	9	23	7.0	1.5	.47
14	16	5.0	1.1	.33	5	24	7.7	1.6	.51
11	17	5.1	1.1	.34	1	25	8.0	1.7	.53
9	18	5.5	1.2	.37	1	26	9.0	1.7	.60
4	19	5.4	1.3	.36					

Tables 2 and 3 represent white and red pine in planted groves of the same age and under similar soil and climatic conditions. The height classes range regularly from 11 to 25 feet in the white pine and from 12 to 25 in the red. However, 90 per cent of the white pine has been affected by the weevil, and not less than 2 feet and in some

cases as much as 6 feet in height growth has been lost thereby. Fifty per cent of the red pine is from 12 to 15 feet in height and from 2.7 to 4.4 inches in diameter, while of the white pine more than 50 per cent is from 15 to 19 feet in height and from 4 to 5.2 inches in diameter. In other words, in white pine the greatest number of trees are midway between the extremes of height and diameter, whereas in the red pine the majority are toward the smaller sizes; only 22 per cent of the trees are more than 18 feet in height and more than 5.1 inches in diameter. The relative growth of the two species in this plantation does not hold good for other parts of New England, where the red pine steadily outgrows the white, as subsequent tables will show.

TABLE 4.—*Growth of planted white pine, East Greenwich, R. I.*

PLANTATION OF H. G. RUSSELL.

[Based on 439 trees 23 years planted.]

Division.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
		<i>Feet.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>Inch.</i>
I.....	1	18	3.0	0.8	0.13
	2	19	4.0	.8	.17
	1	20	4.0	.9	.17
	7	21	5.2	.9	.23
	18	22	5.9	1.0	.26
	21	23	6.3	1.0	.27
	30	24	6.4	1.0	.28
	41	25	6.7	1.1	.29
	38	26	6.5	1.1	.28
	23	27	7.1	1.2	.31
II.....	31	28	7.2	1.2	.31
	20	29	7.2	1.3	.31
	18	30	7.9	1.3	.34
	24	31	8.3	1.3	.36
	27	32	7.7	1.4	.33
	19	33	7.4	1.4	.32
	15	34	8.2	1.5	.36
	15	35	8.1	1.5	.35
	21	36	8.4	1.6	.37
	9	37	8.6	1.6	.37
	11	38	8.6	1.7	.37
	12	39	9.6	1.7	.42
	4	40	10.6	1.7	.46
	5	41	9.8	1.8	.43
III.....	6	42	11.1	1.8	.48
	4	43	10.9	1.9	.43
	9	44	10.1	1.9	.44
	3	45	11.3	2.0	.49
	1	46	12.5	2.0	.54
	3	47	11.2	2.0	.49



A SEED SPOT IN THE FOREST.

FIG. 1.—WHITE PINE WEEVIL AT WORK IN TERMINAL SHOOT.



FIG. 2.—GOOD RECOVERY AFTER ATTACK OF WHITE PINE WEEVIL.

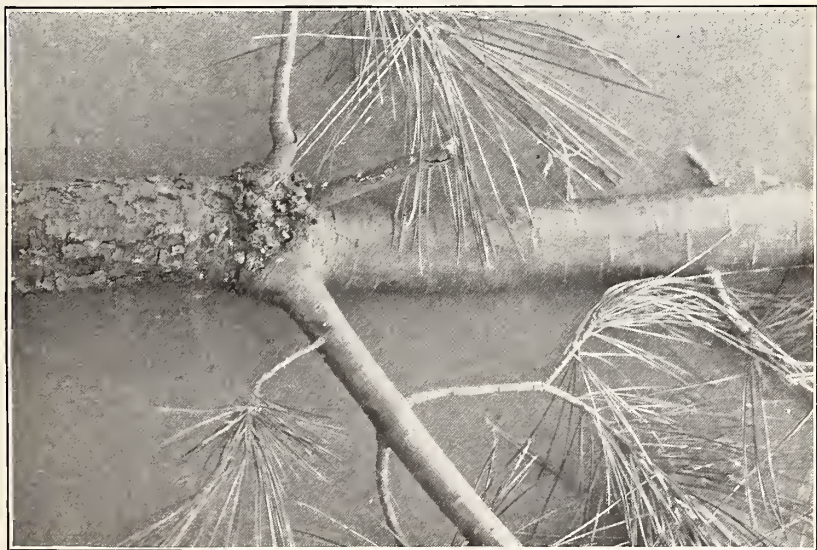




TABLE 5.—*Growth of planted Norway spruce, East Greenwich, R. I.*

PLANTATION OF H. G. RUSSELL.

[Based on 30 trees 23 years planted.]

Division.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
I.....	1	23	5.5	1.0	.24
	1	26	6.0	1.1	.26
	1	27	6.0	1.2	.26
	1	28	3.0	1.2	.13
II.....	2	29	7.0	1.3	.30
	2	30	7.0	1.3	.30
	2	31	6.3	1.3	.27
	4	32	7.0	1.4	.30
	3	33	7.3	1.4	.32
	3	34	7.2	1.5	.31
	3	35	7.3	1.5	.32
	3	36	7.8	1.6	.34
III.....	1	37	7.0	1.6	.30
	2	38	6.8	1.7	.30
	1	40	9.0	1.7	.39

Tables 4 and 5 represent planted groves of white pine and Norway spruce, each 23 years of age, and give opportunity for a comparative study.

The area from which Table 4 was taken has a light, sandy soil. It has a little undergrowth of white oak and red cedar and a small amount of white pine reproduction. The forest floor is composed of 1 to 1½ inches of needles. The suppressed trees constitute only 3 per cent of the stand, and those which have made extra rapid growth 6 per cent. Thus 91 per cent of the grove has made an evenly distributed height increment of from 22 to 39 feet.

Division I, Table 5, containing trees 23 to 28 feet in height, constitutes 10 per cent of the stand, and Division III contains 14 per cent. Division II, comprising 76 per cent of the total stand, is made up of trees averaging from 29 to 36 feet in height and from 7 to 8 inches in diameter. The growth here is very much more even than that of white pine of the same age and under similar conditions. While the pine grows from 22 to 39 feet, the spruce grows from 29 to 36 feet. The average diameter growth of the spruce has been 1 inch in three and one-half to four and one-half years, while that of the pine has been about 1 inch in three years. The spruce makes a rapid growth, produces seed prolifically, and is of good form for utilization, being straight and conical. Its value is much enhanced for tree-planting purposes because of its early maturity and excellent qualities for general usage.

IMPORTANT FACTS ILLUSTRATED.

Some of the most important facts which have been illustrated in Mr. Russell's planted forest are as follows:

(1) White pine is well adapted to sandy and exposed positions, provided it be protected from the direct influence of salt sea winds.

(2) European larch is suited for mixture with white pine where it is desired to produce lumber of good quality in the latter.

(3) White pine and red pine are of comparatively even growth and make a fairly good mixture.

(4) White pine and Norway spruce are admirably adapted for mixed growth.

(5) Pruning is accomplished with best effect when the sap is flowing sluggishly, in August, September, and October, for then the cut surfaces become covered with pitch, thus preventing decay. The wound of a pruned tree is readily and rapidly healed if the cut is made close against the trunk, even when a portion of the bark is removed.

(6) Close planting (4 by 4 feet) is practicable whenever thinning can be done within twenty years. A moderate width (6 by 6 feet) yields the best results where early thinning can not be practiced. Wide spacing (8 by 8 feet) should never be practiced unless the object be protection, for the result is usually a low, dense, bunchy tree, of little or no timber value.

(7) Protective planting may usually, with careful management, be made as inexpensive as commercial planting. The two may often be combined.

PLANTED FOREST OF MR. ISAAC ADAMS, MOULTONBORO, N. H.

LOCATION.

Moultonboro, Carroll County, N. H., is situated at the head of Lake Winnepesaukee, and lies between Red Hill and the Ossipee Range, foothills of the White Mountains.

Bordering the lake, hemlock and hardwoods, including yellow and gray birch, sugar and red maple, and white and scarlet oak, are the more important native trees. On the lower slopes of the mountains white pine is the most prominent tree, mainly in mixture with yellow birch and hemlock.

The plantation of Mr. Adams is in two parts, which are located, respectively, one-half mile and 3 miles south of Moultonboro, on the Wolfboro highway. The location is comparatively low, bordering the western base of the Ossipee Mountains. The soil varies from almost pure sand to a rich sandy loam, but in no place has it displayed any drifting tendency.

OBJECTS.

In general the objects of the planter were as follows:

- (1) To demonstrate the practicability of forest planting in a forested region.
- (2) To improve and utilize land which because of its remoteness from market was of little agricultural value.
- (3) To make use of a large quantity of white pine seedlings which had sprung up from a natural seed year.

HISTORY.

In May, 1868, planting was begun on the larger and more southerly of the two areas. The plantation was then extended westerly toward Lake Winnepesaukee and south along the Wolfboro highway. Yearly planting continued until 1874, when the small area one-half mile south of Moultonboro was planted. In all, about 75 acres were planted during this time, the greater part to white pine.

Seedlings were collected from Mr. Adams's land, mostly from the immediate neighborhood of the plantation, by a collector who guaranteed that the trees would grow or be replaced, and received \$10 per 1,000 for his work. Each seedling was to be carefully lifted from the ground with a spade, taking several inches of sod. They were spaced about 4 by 4 feet apart.

The average number of trees set per day by one man was 300. Extreme care was taken to make the trees succeed. One dry season two men were employed for two weeks at \$1.50 per day to water the young trees. As a commercial forest the plantation is a failure, the outlay having, with interest, amounted to more than the probable return from the timber, but it teaches some very important lessons on the handling of pine plantations.

CONDITION OF THE FOREST.

A very noticeable feature of this forest is the extreme slinness of the trees. This is due to thick planting. As a consequence the branches died while still small, most of them having attained a diameter of less than one-half inch. The entire plantation was pruned to a height of 6 feet, but the work was carelessly done, the branches having been cut at about 1 inch from the tree. (See Pl. XIII, figs. 1 and 2. Fig. 1 illustrates the way pruning has been done on the Adams estate and many others. Fig. 2 shows the same tree properly pruned.)

The trees have grown better and larger where the land is low and moist, forming so dense a shade as almost completely to bar undergrowth. Where the soil is heavier the white pine, while not so tall, holds its crown better and is more healthy in appearance.

In the midst of this forest is a small grove of red (Norway) pine which was planted at the same time as the white pine. The trees are larger than the white pine, and they seem better adapted to growing close planted, as they do not afford such heavy shade. The trees have pruned themselves well, even better than the white pine.

The main area of the plantation is level, and extends from the Wolfboro highway westerly toward Winnepesaukee Lake, in a narrow strip, for over half a mile. The land is quite low, and the soil is a rich, deep, sandy loam, underlaid with gravel. A scattered and irregular mixture of red pine occurs throughout.

Here is noticed more than elsewhere the great difference between the growth of white pine and that of red pine in close mixture. While the white pine averages less than 4 inches in diameter and 25 feet in height, red pine averages 6 to 7 inches in diameter and 30 to 35 feet in height. Red pine has developed larger branches than white pine, and hence has a greater crown surface. The former seems also better able to heal over wounds than the latter. Dead branches of red pine decay and fall, while those of the white pine adhere tenaciously to the trees.

One-half mile southeast of the post-office of Moultonboro is the youngest portion of the forest, planted in 1874. The land had been cropped and was in good condition for planting. This portion has succeeded better than any of the others, mainly because thinning was practiced when needed, thus giving opportunity for the development of a large crown. The first thinning was made when the trees were 21 years old. The crowns are in excellent health and the trees tall and straight, having made a height growth of from 40 to 55 feet.

MEASUREMENTS.

In Mr. Adams's planted forest over 40,000 white pine were measured. Measurements of red pine were also taken to find its growth in comparison with white pine. The following is the rate of growth for the whole plantation:

TABLE 6.—*Growth of planted white and red pine, Moultonboro, N. H.*

PLANTATION OF ISAAC ADAMS.

Age.	Species.	Average height.	Average diameter breast-high.	Number of trees measured.
<i>Years.</i>		<i>Fect.</i>	<i>Inchs.</i>	
27	{White pine.....	43.5	5.2	1,758
	{Red pine.....	48.0	6.6	19
30	{White pine.....	26.6	3.7	40,758
	{Red pine.....	35.4	5.9	4,548

The much better showing of the 27-year-planted trees in comparison with the 30-year-planted is due partly to better soil conditions and partly to the beneficial effect of thinning.

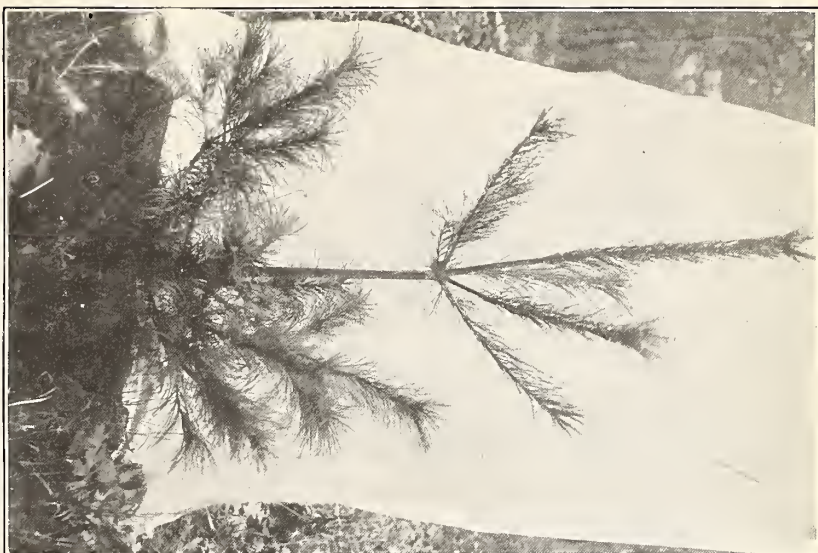


FIG. 1.—A 3-YEAR-OLD NURSERY-GROWN SEEDLING AFTER BEING TWO YEARS PLANTED IN THE FOREST.



FIG. 2.—YOUNG WHITE PINE TWO YEARS AFTER BEING SET IN A MATURE FOREST, SHOWING MUCH OF OAK AND CHESTNUT LEAVES.



TERMINAL SHOOT OF WHITE PINE, SHOWING EXCELLENT GROWTH AND SEED PRODUCTION.

The following tables present the results of measurements of white pine and of red pine made on representative areas:

TABLE 7.—*Growth of planted white pine, Moultonboro, N. H.*

PLANTATION OF ISAAC ADAMS.

[Based on 695 trees 30 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
6	15	2.8	0.5	0.09	47	28	4.6	0.9	0.15
5	16	2.4	.5	.08	48	29	4.8	1.0	.16
13	17	2.2	.6	.07	44	30	4.9	1.0	.16
24	18	2.6	.6	.09	30	31	5.1	1.0	.17
17	19	2.7	.6	.09	34	32	5.4	1.1	.18
30	20	3.1	.7	.10	26	33	5.2	1.1	.17
41	21	3.5	.7	.12	17	34	5.7	1.1	.19
68	22	3.7	.7	.12	9	35	5.8	1.2	.19
42	23	4.1	.8	.14	5	36	6.6	1.2	.22
51	24	4.1	.8	.14	2	37	5.3	1.2	.18
36	25	4.4	.8	.15	1	38	5.0	1.3	.17
43	26	4.7	.9	.16	1	39	6.0	1.3	.20
55	27	4.7	.9	.16					

Table 7 presents measurements which illustrate the general rate of growth of the plantation. The average height rate is a little less than 1 foot per year, and the diameter rate about 1 inch in 7 years.

Table 8 following shows the growth of 30-year-planted red pine on a representative area.

TABLE 8.—*Growth of planted red pine, Moultonboro, N. H.*

PLANTATION OF ISAAC ADAMS.

[Based on 61 trees 30 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
1	20	2.0	0.7	0.07	4	35	4.6	1.2	0.15
1	28	3.0	.9	.10	3	36	5.0	1.2	.17
3	29	3.5	1.0	.12	7	37	5.2	1.2	.17
4	30	3.8	1.0	.13	8	38	5.8	1.3	.19
3	31	4.3	1.0	.14	4	39	6.3	1.3	.21
10	32	4.2	1.1	.14	2	42	7.8	1.4	.26
6	33	4.3	1.1	.14	1	44	7.5	1.5	.25
4	34	4.1	1.1	.14					

To determine the rate of annual growth of the planted in comparison with the native trees, a large number of measurements were taken in and near the Moultonboro plantation. The results are presented in the two following tables. Table 9 shows the annual height growth of

planted white pine for twenty-eight years, and Table 10 of native white pine for eighteen years in the same region and under similar conditions.

TABLE 9.—*Growth of planted white pine, Moultonboro, N. H.*

PLANTATION OF ISAAC ADAMS.

[Based on 25 trees 28 years planted.]

Age.	Average annual height growth.	Age.	Average annual height growth.	Age.	Average annual height growth.	Age.	Average annual height growth.
Years.	Fect.	Years.	Fect.	Years.	Fect.	Years.	Fect.
1	0.4	8	2.1	15	2.0	22	1.3
2	.5	9	2.3	16	2.1	23	1.2
3	.7	10	2.4	17	1.9	24	1.2
4	.9	11	1.9	18	1.8	25	1.2
5	1.4	12	1.9	19	1.6	26	1.1
6	1.8	13	1.8	20	1.6	27	1.0
7	2.0	14	2.1	21	1.5	28	.9

TABLE 10.—*Growth of native white pine, Moultonboro, N. H.*

OWNED BY ISAAC ADAMS.

[Based on 50 trees 12 to 18 years planted.]

Age.	Average annual height growth.	Age.	Average annual height growth.	Age.	Average annual height growth.	Age.	Average annual height growth.
Years.	Fect.	Years.	Fect.	Years.	Fect.	Years.	Fect.
1	0.4	6	0.7	11	0.9	16	0.9
2	.3	7	.9	12	.9	17	1.1
3	.4	8	.8	13	1.0	18	1.2
4	.5	9	.7	14	.8		
5	.6	10	.8	15	1.3		

A comparison of the above tables discloses several suggestive facts. In the first place, the growth of the planted pine during its first eighteen years was more than double that of the native pine for the same period. The ratio of increase, however, is by no means uniform. On the contrary, there is a well-defined difference in the way in which the tree has made its height growth under the two sets of conditions, which the continuation of the table for planted pine through the twenty-eighth year makes still more evident. The planted pine made its maximum growth (29.1 inches^a) in the tenth year. It began to grow rapidly in the fifth year, and continued to do so pretty uniformly until the seventeenth year had passed. From that point, however, the rate declines gradually, until in the twenty-eighth year the growth is

^a The corresponding figures in the table, being given in feet and carried out only to the first decimal place, makes the growth for this year appear the same with that for the ninth year. Similar apparent discrepancies between the text and the tables are due to the same cause.

only 10.7 inches. The native pine, on the other hand, increased its height at a steadily accelerating rate during the entire eighteen years, the last year showing the greatest increase of all except the fifteenth.

There are other differences between the planted and native forests in this particular case which do not appear in the tables. The present condition of the native is better than that of the planted; the crowns are larger, and the last growth is more vigorous. But the stems of the planted portion are free of large branches and hence will make better timber. Again, the average diameter of the native tree was considerably greater than that of planted trees of the same age on most of the tract.

The crowded condition of the planted trees explains these facts. In parts of the plantation where thinning relieved this condition a very different state of things appeared. Here the diameter of trees several years younger was greater than that of either the planted or the native trees measured for Tables 8 and 9, and the height growth also was proportionately improved.

IMPORTANT FACTS ILLUSTRATED IN THE ADAMS PLANTATION.

Some of the more important points brought out in the planted forest of Mr. Adams are as follows:

(1) Seedlings collected from the forest, when properly treated, grow successfully.^a

(2) Ten dollars per 1,000 is too high a price to pay for trees when planting for commercial purposes.

(3) Watering seedlings is impracticable.

(4) Unless the demand for small timber is great, it is not advisable to plant so closely as 4 by 4 feet, for the first thinning can not be made except at an expense which it is unwise to incur.

(5) If 3- or 4-inch stuff can be sold for fuel or other purposes at a price that will pay for the cutting, close planting may be advantageous.

(6) The growth of planted pine is considerably greater than that of native pine under similar conditions for at least the first twenty years, and probably for several years longer, where the trees are not greatly crowded.

(7) Planting at 4 by 4 feet causes a decrease in growth between the fifteenth and the thirtieth year. Shortly after that time the best trees become dominant, and resume a rapid growth, while a large percentage become suppressed and die.

(8) Closely planted trees produce the straightest and cleanest boles, and hence timber of the finest quality.

^aExperience elsewhere shows that it is not necessary to leave a portion of sod adhering to each seedling. If the earth be carefully shaken off, and the roots puddled in a mixture of rich earth and water to prevent drying, as good results are obtained, and at much less expense.

**PLANTATION OF MRS. FREDERICK BRUNSON, GREENFIELD
HILL, CONN.**

A short distance west of Greenfield Hill, Fairfield County, Conn., is located a plantation of about 30 acres of white pine and European larch.

The planting was done in the spring of 1886 with 7-inch white pine and European larch seedlings bought from a western nursery. The land had been plowed and was in good physical condition, and the work was performed at the rate of nearly an acre a day for each man employed. The trees were set 4 by 6 feet apart, and the cost for labor was \$48, with labor at \$1.50 per day. The arrangement was as follows, P indicating white pine and L European larch:

P	L	P	L	P	L	P
L	P	L	P	L	P	L
P	L	P	L	P	L	P
L	P	L	P	L	P	L
P	L	P	L	P	L	P

CONDITION OF THE FOREST.

The forest floor consists of an evenly distributed mat of leaves and pine needles, which is in good condition and acts as a mulch. The edge of the plantation has been shaded by native deciduous trees, which have cleared the pines of side branches.

The interior is composed of trees of remarkably good size and form for so young a grove, several trees measuring 8 inches in diameter. The lower branches to a height of 15 to 20 feet have been dead from two to five years. This shows that in a larch-pine mixture, where the trees are set 4 by 6 feet, when the growth is vigorous the density is sufficient to kill the lower branches at about the tenth year.

GROWTH.

For the first two years the height growth of white pine was slightly over 3 inches per year. The third year it was from 13 to 24 inches. From the fourth to the ninth year the trees grew from 24 to 30 inches per year. After the ninth year this growth diminished, and has since averaged little more than 1 foot per year. The European larch has grown more rapidly than the pine, and averaged 10 feet taller when measured. Nevertheless, it does not retard the growth of the pine, for its form is conical and the foliage is light; the pine, however, kills the side branches of the larch. The dead branches form an extremely dense, bushy thicket from the base to a height of 15 to 25 feet. They cling tenaciously to the stems, but are gradually decaying and will shortly fall. The diameter of the pine is greater than that of the larch.



A GOOD SEEDBED FOR NATURAL REPRODUCTION.



TWO WHITE PINES, EACH 9 YEARS OLD.

The larger tree was grown in the open; the smaller one in rather dense shade.

MEASUREMENTS.

Table 11 represents the most thrifty and fastest growing planted white pine known to the writer. The grove is only 15 years old, yet most of the trees range from 21 to 36 feet in height. The rate of growth in height has varied from an average of 1 foot to 2.4 feet per year for the entire period of growth. Table 12 shows the relative growth of the European larch when planted in mixture with white pine in alternating rows.

TABLE 11.—*Growth of planted white pine, Greenfield Hill, Conn.*

PLANTATION OF MRS. FREDERICK BRUNSON.

[Based on 545 trees 15 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
8	15	2.4	1.0	0.16	34	26	4.9	1.7	0.33
1	16	2.0	1.1	.13	49	27	5.0	1.8	.33
4	17	3.1	1.1	.21	51	28	5.2	1.9	.35
13	18	2.2	1.2	.15	42	29	5.3	1.9	.35
9	19	2.5	1.3	.17	40	30	5.1	2.0	.34
28	20	3.0	1.3	.20	17	31	5.3	2.1	.35
18	21	3.1	1.4	.21	16	32	5.1	2.1	.34
42	22	3.7	1.5	.25	14	33	5.4	2.2	.36
40	23	4.0	1.5	.27	3	34	6.2	2.3	.41
51	24	4.2	1.6	.28	7	35	5.6	2.3	.37
55	25	4.7	1.7	.31	3	36	5.2	2.4	.35

TABLE 12.—*Growth of planted European larch, Greenfield Hill, Conn.*

PLANTATION OF MRS. FREDERICK BRUNSON.

[Based on 519 trees 15 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>		<i>Fect.</i>	<i>Inches.</i>	<i>Fect.</i>	<i>Inch.</i>
1	15	2.0	1.0	0.13	31	31	4.2	2.1	0.28
1	17	3.0	1.1	.20	46	32	4.2	2.1	.28
7	18	2.3	1.2	.15	38	33	4.3	2.2	.30
3	19	2.0	1.3	.13	21	34	4.5	2.3	.30
11	20	2.4	1.3	.16	16	35	4.6	2.3	.29
7	21	2.5	1.4	.17	15	36	4.7	2.4	.31
15	22	2.6	1.5	.17	17	37	4.9	2.5	.31
16	23	2.5	1.5	.17	14	38	5.0	2.5	.32
19	24	3.0	1.6	.20	8	39	5.1	2.6	.35
24	25	3.1	1.7	.21	16	40	5.2	2.7	.34
20	26	3.3	1.7	.22	4	41	5.3	2.7	.36
38	27	3.6	1.8	.24	5	42	5.3	2.8	.41
41	28	3.6	1.9	.24	2	43	5.4	2.9	.37
38	29	3.9	1.9	.26	1	45	5.5	3.0	.33
44	30	3.9	2.0	.25					

The average heights of the trees are, white pine, 26 feet; European larch, 30 feet.

IMPORTANT FACTS ILLUSTRATED IN THE BRUNSON PLANTATION.

The groves at Greenfield Hill illustrate the following conclusions:

(1) Previous preparation of the soil makes possible more rapid planting, and for a number of years insures a more rapid growth.

(2) Good soil, while not essential to favorable growth, gives better results than poor.

(3) Four by six feet is a good distance for planting in mixture with larch when it is proposed to remove larch within 20 years.

(4) The planting of larch in mixture with white pine is of no advantage to the pine, for the larch is the less shade-enduring of the two.

(5) Trees planted at a distance of 4 by 6 feet in a larch-pine mixture will sufficiently prune themselves.

A REPRESENTATIVE PLANTED WHITE PINE WOODLOT.

As an example of the growth of planted white pine in other sections of the East than New England, a brief description is here given of the plantation of Mr. Burnet Landreth at Monaskon, Va.

HISTORY.

In 1873 an area of 6.2 acres was planted to nursery-grown, transplanted white pine trees about six inches high, by Mr. Burnet Landreth, at Monaskon, Va. The young trees were planted 4 by 5 feet (2,178 trees per acre.)

The soil is of poor quality. It is grayish in color and of the consistency of clay, but contains some sand, which improves the physical character. The plantation is located on the tidewater plateau near the Rappahannock River.

CONDITION.

The white pine, though in the southern part of its range and in poor soil, has done far better than in many plantations farther north. The trees have made good growth, continuing without a break to the present time, and are now in good condition.

The lower branches are dead; some have fallen, but most of them still cling to the trunks. Some of the less vigorous trees have been overtopped and have died, owing to lack of light.

MEASUREMENTS.

Table 14 gives the measurements of 208 trees, 27 years planted, at Monaskon. The trees have made regular and normal growth, and show a pretty even distribution through the different height classes from 24 to 60 feet. Their growth in diameter has kept fairly uniform

with the height growth, and varies from about 1 inch in five years for the 30-foot class to 1 inch in a little more than two years for the 59-foot class.

TABLE 13.—*Growth of planted white pine, Monaskon, Va.*

PLANTATION OF BURNET LANDRETH.

[Based on 208 trees 27 years planted.]

Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.	Number of trees.	Average height.	Average diameter breast-high.	Average annual height growth.	Average annual diameter growth.
	<i>Feet.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>Inch.</i>		<i>Feet.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>Inch.</i>
4	24	3.8	0.9	0.14	4	43	7.5	1.6	0.28
4	26	4.0	1.0	.15	6	44	8.1	1.6	.30
8	27	4.3	1.0	.16	12	45	7.9	1.7	.29
5	29	5.0	1.1	.19	7	46	8.5	1.7	.31
4	30	5.2	1.1	.19	23	47	8.5	1.7	.31
7	31	5.6	1.1	.21	2	48	8.0	1.8	.30
3	32	5.3	1.2	.20	5	49	9.0	1.8	.33
7	33	6.0	1.2	.22	4	50	9.5	1.9	.35
2	35	6.5	1.3	.24	2	52	8.7	1.9	.32
12	36	6.4	1.3	.24	5	53	9.5	2.0	.35
4	37	6.9	1.4	.26	10	54	10.5	2.0	.39
7	38	6.5	1.4	.24	3	55	12.5	2.0	.46
21	39	6.9	1.4	.26	1	57	12.5	2.1	.46
10	40	6.7	1.5	.25	1	59	12.5	2.2	.46
15	41	7.4	1.5	.27	5	60	13.5	2.2	.50
5	42	7.5	1.6	.28					

GROWTH.

The average rate of growth of 21 white pines in the plantation at Monaskon was as follows:

TABLE 14.—*White pine plantation of Burnet Landreth, Monaskon, Va.*

Age.	Height.	Average annual growth per 5-year period.
<i>Years.</i>	<i>Feet.</i>	<i>Feet.</i>
5	2.5	0.5
10	9.7	1.4
15	23.3	2.7
20	34.7	2.3
25	41.1	1.3
27	42.8	.85

In most of the planted white pine groves of New England the cover has been too dense to permit of much reproduction.

Good reproduction may be found at Bridgewater, Mass., where groves of Mr. Wood and Mr. Adams were planted forty to fifty

years ago and are now fairly open. In the plantation of Mr. Wood a strip 12 by 198 feet, extending throughout a representative portion of the grove, was laid off, and all the young pines were counted. (See below, Plat I.) The ground covered consists of about 3 inches of pine needles. Most of the plantation of Mr. Adams is still too dense to allow of reproduction; but a spot containing 1.5 square rods, where an opening allowed partial sunlight, was selected for a count, with the results given below. This represents the part where reproduction is best. There is a good mat of pine needles, in some places covered with moss. The number of seedlings, with their ages, was found to be as follows:

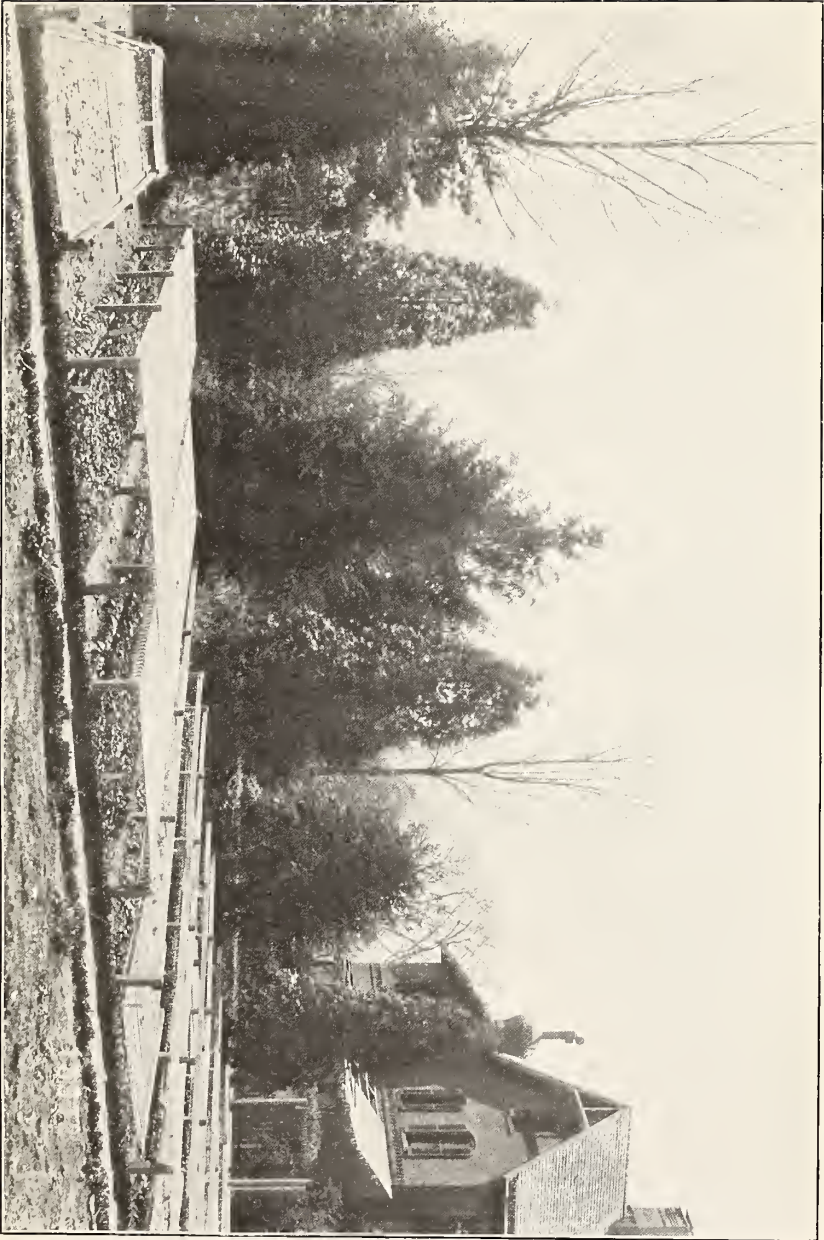
TABLE 15.—*Reproduction of white pine planted forest, Bridgewater, Mass.*

Age.	Plat I. Area, 8.72 square rods.	Plat II. Area, 1.5 square rods.
	Number of seedlings.	Number of seedlings.
1 year	261	70
2 years	1,227	212
3 years	25	.....
4 years	9	.....
5 years	4	.....
6 years	6	.....
7 years	1	.....
8 years	2	.....
Total	1,535	282
Total per acre	28,229	30,080

At Plymouth, Mass., the late Nathaniel Morton encouraged natural reproduction in an old pine grove by removing the scrubby oak which had followed annual fires. Reproduction counts made on blocks one-half rod by 60 rods in representative portions gave the following results:

TABLE 16.—*Reproduction of white pine, Plymouth, Mass.*

Height.	Number of trees.			
	Block I.	Block II.	Block III.	Block IV.
0.1 to 0.5 foot	187	160	393	78
0.5 to 2 feet	141	38	276	88
3 to 5 feet	61	15	56	39
6 to 10 feet	33	8	4	18
11 to 20 feet	16	2	1	16
21 to 35 feet	5	2	2	3
36 to 50 feet	5	9	14	8
Total	448	234	746	250
Total per acre	2,389	1,248	3,979	1,333



SEEDBEDS WITH MOVABLE SHADES.



SOIL OF SUITABLE CHARACTER FOR FIRST-RATE GROWTH OF WHITE PINE.

The plantation shown in the frontispiece stands on similar soil.

Near Winchester, N. H., in a 2-acre cut-over area which is surrounded by old pines, 596 seedlings were found on a strip 200 feet long by $8\frac{1}{4}$ feet wide, or at the rate of 15,843 to the acre; and on a second strip 250 feet long by $8\frac{1}{4}$ feet broad, 409 seedlings, or at the rate of 8,725 per acre. In places the undergrowth was so dense that reproduction was not possible. The young trees vary from 4 inches to 7 feet in height, and form a most excellent stand.

While it is to be said that the above counts represent better than average conditions, the fact remains that with a little care, provided there are seed trees, a stand of white pine, whether native or planted, may be reproduced at little expense.

MIXTURES USED AND THEIR COMPARATIVE VALUE.

In early planting a great variety of mixtures were used. Some of these proved successful, but others were not suited to the growth of white pine. The pure white pine plantation has usually made a satisfactory growth, but its use, at least when nursery stock has to be bought, involves a greater outlay than is necessary. A less expensive tree may be used in mixture with it, and if properly chosen will not diminish the products of the plantation.

EUROPEAN LARCH.

The European larch has been frequently used with the white pine, and in some cases satisfactorily. It is more rapid in height growth than the pine, but less rapid in diameter growth. In the very excellent plantation of evenly mixed white pine and European larch at Greenfield Hill, Conn., the white pine reached in fifteen years an average height of 28 feet and a diameter of 4.2 inches, while in the same time the larch grew 32 feet in height and only 3.5 inches in diameter. The larch in New England is liable to attacks from insects. Its intolerance permits the dense, shade-enduring branches of the pine to shade out its side branches. This is advantageous to the larch, but is a service which the latter can not reciprocate. The mixture benefits the larch, but is of no material value to the pine.

OAKS.

The red and scarlet oaks grow at about the same rate as white pine, and are well adapted to planting with it. They are sufficiently tolerant to aid in clearing the pine of its branches, and as they are valuable for some purposes when quite young they can generally be utilized when it becomes desirable to remove them. Oaks are transplanted with difficulty, owing to the long tap root, and in raising them from seed it is necessary to protect the acorns from rodents.^a

^a Acorns or chestnuts may be planted in pastures by simply making a hole with a cane or stick. The best protection in such a case is to stamp the sod firmly against the acorn with the heel.

When this has been done acorn planting has usually been successful on open ground. But where other species spring up naturally it has, as a rule, been unsuccessful. White oak, though a more valuable tree than either red or scarlet oak, is not adapted to mixture with white pine, owing to its slow growth. Red and scarlet oak may be used in mixture with white pine throughout its entire range.

CHESTNUT.

Chestnut is a valuable tree for use with white pine. While the oaks are slightly slower than pine in growth, chestnut is a little more rapid. It has the advantage, too, of being valuable for fence posts, even when young, so that when it begins to overtop the pine it may be cut out profitably. It takes from fifteen to twenty-five years for pine to become sufficiently large to completely shade the ground; the chestnut may then be cut and used for posts, telegraph poles, or railroad ties. Chestnut may be used in mixture with white pine throughout the New England States, New York, Pennsylvania, New Jersey, Delaware, Maryland, and Virginia, and in the Appalachian region south to Georgia and Alabama.

SCOTCH PINE.

The mixture of Scotch pine with white pine is satisfactory so far as the growth of each species is concerned. There is little advantage gained, however, for it is as expensive to plant Scotch pine as white pine, and the result is a tree of a smaller timber value. The Scotch pine is not a native of America, but its range for economic planting extends throughout the range for white pine, and west as far as the Plains. Scotch pine is hardy under a great variety of conditions, but in almost every case is of less value than some other species.

RED PINE.

In several plantations red pine has been used with white pine. The result is rather unsatisfactory, for in most cases it grows more rapidly than the latter, and, when planted in equal quantity with it, shades it too heavily with its broad, spreading crown. In New England the difference in growth is accentuated by the dwarfing effect of the white-pine weevil. The result is that the white pine is gradually superseded. In a 27-year-old forest of these two species, white pine showed an average height growth of 27.5 feet, and red pine of 34.9 feet. Their relative growth is well shown in the plantation of Mr. Isaac Adams, in Moultonboro, N. H., where the red pine invariably overtops and is usually detrimental to the growth of the white pine.

In one respect the mixture of red and white pine behaves like that of larch and white pine. White pine is more tolerant than red, and consequently shades out the side branches of the latter, forming a clear bole, while the branches of the white pine continue, so that the

tree is almost valueless for timber. Probably no better tree could be used as a nurse for red pine than white pine, but when white pine is desired such a mixture is not advisable.

The range of red pine for economic planting extends throughout the Northern States as far west as eastern North and South Dakota.

NORWAY SPRUCE.

In many cases there is no tree better suited to growth with white pine than Norway spruce. This tree is valuable because of its early maturity and the quality of its wood. In East Greenwich, R. I., where both were planted on poor, sandy land, the white pine grew 28 feet in twenty-seven years and the Norway spruce 32 feet. The conical shape of the spruce prevents its slightly more rapid height growth from injuring the white pine. Both spruce and pine are shade enduring, so that the mixture is good for both. Norway spruce may be planted throughout the region of the white pine.

SUGAR MAPLE.

For economic forest planting there is probably no other tree which can be used in mixture with white pine to greater advantage than sugar maple. Its shade-enduring quality, its relative growth, and the readiness with which it may be obtained are all in its favor. The main disadvantage in planting pure white pine forests is the large initial outlay. Sugar maple seedlings may be obtained for one-half what white pine costs, and the mixture makes it necessary to plant only just enough pines to form the future stand.

For the first twelve years the annual height growth of the two species is about equal. Then the maple begins to spread out, while the pine continues to grow rapidly until, by the time it is 20 years old, it has secured a substantial lead. Meanwhile the thick and spreading crown of the maple has killed out the lower branches of the pine. It has now fulfilled its part, and may be removed if use can be made of it. If not, it will gradually be killed by the rapidly advancing growth of the pine, which will by this time form a complete forest cover.

STARTING A WHITE-PINE PLANTATION.

SEED AND SEED YEARS.

The white pine is reproduced from seed. The cones, which average about 6 inches in length, bear from 50 to 75 seeds each. There are about 28,800 seeds to the pound, or 1,800 to the ounce. The percentage of germination in fresh seed is 70 to 90. If the seed is sown carefully in drills on suitable soil and cared for in a proper manner subsequently, 50 per cent may be expected to produce seedlings which will live to the transplanting stage. If, however, seed be sown broadcast on soil not properly cared for, a frequent result is not more than 2,000 to

5,000 seedlings from the pound. At this rate it would pay the planter better to buy two- or three-year seedlings from a nursery or collect them from the forest. White-pine seed costs from \$1.50, when the seed is plentiful, to \$3 or \$4 per pound during the period between good seed years. "Seed years" occur once in four to seven years. Seed-bearing cones are found usually in small numbers on scattered trees in the intervals between seed years, and in some cases seed years occur locally in the interval between general seed years. In such instances collectors may take advantage of the local crop to secure large quantities. Since white pine seed requires two years for development, it is possible to predict a seed year twelve months previous to the time for collection. Ample opportunity is thus given to prepare for planting when seed may be obtained at the smallest cost to the planter.

COLLECTING AND STORING SEED.

The white pine cone opens and throws its seed before it falls from the tree, consequently it is necessary to collect the cones before they open. Different methods of collecting have been used in various parts of the country. Until recent years, where the timber was abundant, some collectors chopped the trees down; others lopped off branches. In regions of less supply seed has been collected by the use of "climbers" similar to those used by telegraph linemen. The cones are then picked by hand, or the small branches bearing them are cut with long-handled pruning shears. The quickest method is that of chopping the trees and picking the cones by hand from the fallen trees; but this should never be resorted to unless the trees are mature and can immediately be used for lumber. In such instances it is sometimes advisable to wait for a seed year before harvesting a crop of timber. Lopping off large branches should never be resorted to unless the branches be cut close to the stem, in which case the pruning benefits the future timber, provided the crown is not robbed. Where trees have large crowns the tips of the lateral branches may be removed with pruning shears without injury to the trees, but the upper part of the crown should never be disturbed except by hand picking. A long pole, with a sharp, curved steel knife at the end, may be used to advantage in picking cones which can not be reached readily by hand. It is usually possible to obtain seeds most easily from trees which are grown in open fields or along roadsides, for in such places the crowns have a better opportunity for development, the trees are lower and more dense, and they bear more and frequently better seed.

Seed should be stored in a cool, dry place, in small bags suspended in the air. Light freezing is not injurious, but heavy freezing should be guarded against.



TWO-YEAR-OLD WHITE PINE SEEDLINGS. GOOD SIZE FOR PLANTING.



FIG. 1.—A POORLY PRUNED TREE.

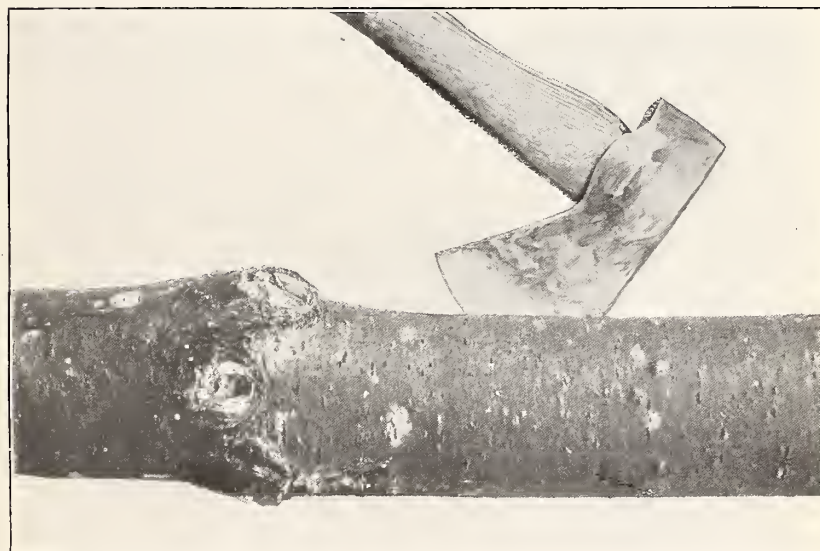


FIG. 2.—SAME TREE WELL PRUNED.

PREPARATION OF SEEDBED, SOWING, AND SHADING.

One of the first considerations in starting a seedbed of white pine is the choice of a suitable situation. The most important requirements are as follows:

(1) *A deep, porous, sandy loam soil.*—It is not necessary that the seedbed be particularly fertile, unless it is to be used for many years, so long as it has a good admixture of humus. It is important that the soil be sandy or light, for in such soil there is less danger of “damping off,” which is the result of a fungus caused by excessive moisture, and of “heaving” from frost action.

(2) *Good drainage.*—This is necessary no matter what the soil. There must be no spots where the water will stand either on the surface or in the soil even for a few hours.

(3) *New soil.*—Where possible, land should be used which has not been recently cropped. It is also desirable that the nursery should be some distance from any cropped field. The advantage of such land is that it will contain few or no weeds, and hence will require far less hoeing and expensive hand weeding. Some of the most successful nurseries in this country have been made in the midst of scrubby woods. The brush and trees were “grubbed” out, and the soil (sandy loam) completely pulverized with plow and harrow. The cost of preparing such a nursery will range from \$20 to \$100 per acre, according to the condition of the land and the cost of labor. For the home woodlot, however, a small plot may be prepared at no expense except a few hours’ work.

(4) *Convenient location.*—In selecting the location of the seedbed, nearness to the house of the care-taker, to the land which it is proposed to plant, and to a water supply are all worth consideration.

The location having been chosen, it should be completely cleared of stumps and débris and brought to an even surface. The land should be plowed moderately deep, and harrowed until thoroughly pulverized. Seedbeds do not need to be raised above the general level unless the soil is wet. They are preferably laid out on the level ground in beds 4 feet wide and any multiple of 6 feet long, as 24, 60, or 120.

The rows in the seedbed may be laid out 6 to 12 inches apart, 6 inches being sufficient when a single drill is to be sown, 10 inches when two drills are made in each row, and 12 inches when three drills are made. The marker (see fig. 1) is made of triangular strips of wood (*a*). The strips may be from one-half to 1 inch in thickness and from 12 to 18 inches long, as desired; but the size should be uniform. Should the planter desire only one drill in each row, single triangular strips should be set 6 inches apart against cross strips (*b*) near either end. The whole can be made firm by a diagonal strip (*c*). For the two-drill row two triangular strips should be placed 1 to 1½ inches apart, and the sets

10 inches apart. For the three-drill row three strips should be placed 1 to $1\frac{1}{2}$ inches apart, and the sets 12 inches apart. In use, the marker is simply pressed gently against the soft, fine earth of the seedbed so that the sharp edges of the strip will sink about one-fourth of an inch into the soil. It may then be lifted and set again in another place, or it may be slowly pulled along, making two rows of drills at a time. The seed should be planted immediately after using the marker, so that the soil may not become dry. Seeds should be dropped one-half to 1 inch apart in the row. Should there be more than one drill in a row, the latter distance is preferable. Seeds may be conveniently dropped from a small-necked bottle by holding the thumb over the opening and allowing the seeds to drop out rapidly one by one.

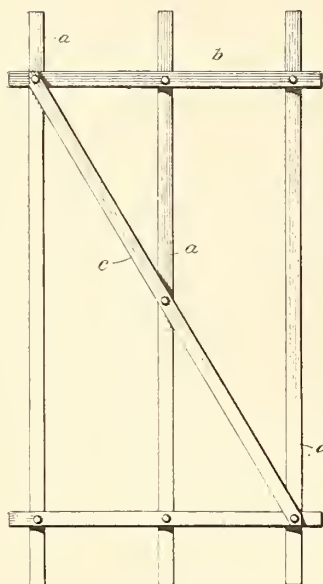
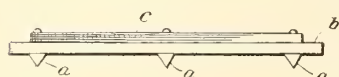


FIG. 1.—Marker.

When the seed has been planted, fine moist soil should be sprinkled in the drills to a depth of one-fourth of an inch. The soil should then be made firm by rolling the beds with a light hand roller. If this is not available, a smooth board may be pressed firmly against the soil with the foot.

It is better to sow the seed when the weather is moderately cloudy, but not wet. The seed of white pine does not need much moisture for germination, and an oversupply is injurious.

Growth for the first year is slow, and the young plants are very tender. They therefore require shade and care. The frame may be constructed of cloth, like the ordinary tobacco frame, or it may be a half shade of lath frames (fig. 2). These frames are usually most convenient in 6-foot lengths and for beds 4 feet wide.

The 6-foot strips to which the laths are nailed may be conveniently 1 by 3 inches or 1 by 4 inches. Posts 2 by 2 inches or 2 by 4 inches, and sufficiently long to protrude 12 inches above the surface, should be placed accurately every 6 feet, so that the sections may rest upon them.

Under favorable conditions germination takes place in from ten to fifteen days, and three weeks from the date of planting should see many seedlings above ground. Weeds should be carefully removed and the soil kept continually loose and porous. Excess of water should be excluded. This may be accomplished by using the shade as a partial roof. Should continued rains occur, one side of the shade should be

lifted and propped 12 to 16 inches above the other. This will turn off a portion of the water. Should "damping off" take place, or should the beds become overwet, as soon as the rains cease the shades should be removed, and should remain off until the sun endangers the seedlings.

From the time of the appearance of seedlings above ground they should be carefully watched, weeded, and cultivated. In cultivating, the 6-foot shade sections may be conveniently removed. The cost of

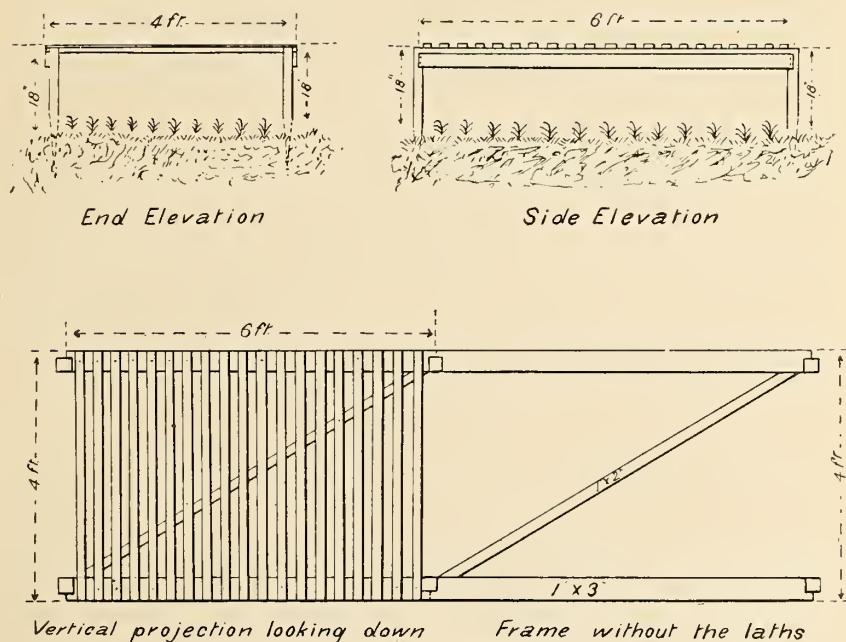


FIG. 2.—Detail of shade frame.

weeding is heavy, hence the importance of choosing land which is as free from weeds as possible. Cultivation should continue through the second season. The shades may be removed some time in August of the second season, after the greatest heat of the summer is past.

THE PLANTATION.

The variation of climatic conditions throughout New England is not sufficient to be of importance, except for the effect of continued salt winds near the coast. Either hilly, level, gently undulating land or low, moderately dry land is suitable for white pine planting, provided the ground cover be not too dense. Low land which is wet or marshy is entirely unsuited for planting; on such land the roots decay and the trees fall before they are big enough to use. Cleared land is best adapted for pine plantations. Land with scattering brush growth may

generally be used without any cutting. Land where the brush growth is dense should be partially cleared before planting is attempted. Cut-over land, where heavy sprout growth follows cutting, may have open spaces where pines may be inserted to advantage, but as a rule it is useless to plant such lands; it costs too much to give the young and tender seedlings enough light. Cut-over lands, where the tendency to sprout is slight and where natural reproduction is of inferior species, may frequently be planted to advantage in whole or part, such planting depending upon the present stand of valuable seedlings or sprouts and the density of shade. Burnt land usually shows a tendency to support rapid-growing, worthless species. Planting may frequently be practiced the season after a fire, or on land where the growth is not very dense.

Where the site chosen is moderately clear of brush growth, seedlings may be used. Should it consist wholly or in part of areas of burnt-over land, sprout land, or brush land, the plants should be once transplanted in the nursery. As transplants cost twice as much as seedlings it is readily seen that such planting is more expensive than planting on open land. The cheaper cost of brush land may, however, sometimes overweigh this difference. The cost of plowing the site is generally prohibitive, and is, moreover, unnecessary.

TRANSPLANTING.

The young seedlings should be transplanted in the late fall, after the summer's growth has become completely hardened, or in the early spring, just as the growth is ready to start. When trees are taken up in the fall for spring planting they should be stored over winter in a protected place, such as a cellar or barn, the roots being covered with moist sand or earth. The purpose of burying the trees is to allow the half-dormant vital functions opportunity to act slowly during the winter season, and to protect the roots from the drying influence of the air and from extreme cold. Trees kept in moist soil in a cellar over winter will form calluses over their wounded surfaces.

Fall planting is sometimes advisable in the North, but spring planting is usually best. Trees planted in the fall are subjected to the heavy frosts of winter, and unless the soil is peculiarly well adapted to hold them the plants are likely to be heaved out. If stored over winter, and protected from the sun in early spring, the period of planting may be much lengthened, for as the buds will not start so soon when the trees are in storage as when exposed to the revitalizing influence of the sun's rays. Trees may be transplanted in the spring direct from the nursery rows to the permanent site, and, if care is used and circumstances are favorable, 95 per cent should grow.

Whether the removal of the plants from the nursery be in fall or spring, the process is the same. They may either be dug with a spade or thrown out by a plow set 6 to 8 inches deep. The trees should then

be carefully lifted, and the clinging earth gently shaken from the roots. Great care should be used to prevent injury to the tender young rootlets.

As the plants are removed from the nursery rows the roots should be immersed in a "puddle" composed of rich earth and water, mixed to the consistency of thin mud. If the trees are to be transported a long distance, clear water should be used instead of the puddle, and the trees carefully packed for shipment.

When the trees are shipped some distance they should be tied in bunches of 100 and the roots wrapped in moist sphagnum moss. Rather small, well ventilated boxes should be used for shipping. Care should be used to pack the trees firmly together in the box, so that bruising will not take place. To prevent shaking it is frequently wise to nail a 1- by 3-inch board, as long as the box is wide, in such a manner that the plants are held firmly in place in the box. It is important that transportation be rapid, and necessary that the roots be kept moist, but not wet, for if kept too wet they will mold. If it is desired to defer final planting after the trees are received, they should, after puddling, be carefully heeled in, in a shady place.

The method of planting will depend upon the condition of the ground, the object of the forest, and the trees with which the white pine is to be mixed. In general, plowing is impracticable in New England and should not be attempted, though where the soil is free from rocks, comparatively level, and in sod, single furrows may frequently be plowed to advantage, each furrow being the line of a row of trees. Planting the trees in these furrows at the desired distance apart is then a simple matter. Each planter should carry a hoe and a bucket containing seedlings, with a little water in it to keep the roots constantly moist. In setting in furrows the roots should be spread evenly over the furrow bottom, and the loose earth from the ridge should be filled in with the hoe and pressed with the foot firmly against the roots.

When it is not practicable to plow furrows, an economical method of procedure is to set up double rows of guide stakes down the sides of the area to be planted, and also, if necessary to enable the planter always to have two stakes in sight ahead of him, an additional row or rows through the middle. By keeping in line with these and planting at every two paces, if the usual 6-foot interval is that desired, the trees will be set with sufficient accuracy. The diagram for working is as follows:

o	x	x	o	x	x	x	x	x	x	x	x	o	x	x	x	x	x	x	x	o	x	x	o
o	x	x	o	x								o								o			o
o			o									o								o			o
o			o									o								o			o
o			o									o								o			o

In planting, either spade or mattock may be used; the latter, however, is usually preferred. Three or four strokes of the mattock (or

after some practice, only one or two) or an edgewise thrust with the spade, is sufficient. Two men can work to advantage in each row, one digging the holes and the other planting. The man with the spade or mattock, after turning up the earth, should at once go ahead the required distance and make another hole, using care that the earth be not scattered but be as nearly as possible a cube, and placed close to the edge of the cavity. The planter should follow immediately behind.

The planter should carry in a bucket several hundred young trees, the roots of which have just previously been puddled. At each hole he should with one hand place the roots of the tree in the cavity, while with the other he lifts the portion of earth which has been removed and brings it down upon the edge of the cavity opposite the tree with sufficient force to break the sod. This process fines the soil and scatters it about the roots of the tree. With the same movement the sod should be replaced, and the planter should then with his heel firmly press the soil about the roots of the tree.

By following the above instructions two common laborers should plant from 1,200 to 1,800 two or three year old seedlings per day, provided the soil conditions are favorable.

In planting it is advised that occasional strips 12 feet wide be left open, to be used as fire lines in case of emergency, and also to be used as driveways and wood roads.

TREATMENT AFTER PLANTING.

PRUNING.

Many of the existing plantations have been pruned, but seldom in the most advantageous manner. At East Greenwich, R. I., the larger trees have been carefully pruned, but at a cost which shows the operation to have been such as to make it impracticable from an economic standpoint. At Bridgewater, Mass., in a plantation not described in this report, stubs an inch or two long were left protruding from the stem. Such pruning is most harmful; the rough surfaces give an excellent opportunity for borers or fungi to work from the limb-butt into the stem.

Correct pruning is of great value. It changes inferior to first-class lumber. It should be done about ten years after the trees have been planted, before the limbs have died. The trees will then average from 10 to 15 or 20 feet in height. They should be trimmed as high as can readily be reached with a hand ax. Pruning should be done in July or August, when there is just enough secretion of pitch to cover the wounds, preventing the access of air and excluding fungi. The cut should be made close to the stem, to insure a thorough covering of pitch and the more rapid healing of the wound. The healing over and complete disappearance of the wound is then very rapid. In

most cases it will be practically completed in two or three years. Pruning may be done very cheaply by using a sharp hand ax and cutting each limb close to the bark with a single stroke.

THINNING.

In plantations where trees are 4 by 4 feet the first thinning should be at fifteen years; where planted 6 by 6 feet, at thirty years. One-half of the trees should be removed. The product of the thinning can frequently be used for fuel, fencing, or other purposes. The second thinning, or first harvest, should be between forty and fifty years after planting. At this time one-half of the remaining trees should be cut. These can in most places be profitably marketed for box boards. After thus removing one-half the stand at each thinning there will still remain a forest in which the stand is 8 by 8 feet to 12 by 12 feet, according as the original distance was 4 by 4 or 6 by 6 feet. The trees may then remain as long as the owner wishes, gaining in value constantly by the improvement of the wood in both quantity and quality. Trees seventy or eighty years old make excellent and valuable timber.

The above is the ideal method, the final cutting leaving sufficient trees to seed the area for the next crop; but many persons have reaped their total crop at 45 years of age, frequently removing 60 cords of box-board lumber per acre.^a

AGE FOR PROFITABLE LUMBERING—COST AND PROFIT.

From the foregoing figures it is readily seen that the age at which the first profitable lumbering may be practiced is between thirty-five and forty-five years from the time of planting. At this time the average diameter of the trees, where grown in the proper density, is 8 to 12 inches. This would not sell in the market as first-class nor even as second-class timber, but trees of this size have in most regions a ready market for use as box boards, and are worth from \$3 to \$5 per cord on the stump. The accepted unit of measure for box-board lumber where sold on the stump is the cord.

There follows an estimate,^b from the data obtained, of the cost and profit of an average 60-acre plantation of white pine on waste pasture land in New England. The cost of the land is put at \$4 per acre, though in many cases it can be obtained for much less. Taxes for the total period are reckoned at 2 per cent of the original value. The rate is made high in order that the amount which is thus allowed for, over that which would actually be required in the early period of

^aThose who contemplate forest planting are referred to Circular No. 22, of the Bureau of Forestry, which describes the assistance given to private owners by the Government.

^bA similar estimate is found in an article in the Yearbook of the United States Department of Agriculture for 1902, entitled "The Practicability of Forest Planting in the United States," by William L. Hall.

growth of the pine, with the compound interest on it for the remainder of the period, may compensate for the increased tax as the land becomes gradually of greater value. It is supposed that the total crop will be cut at the end of forty years from the formation of the seedbed; the owner is to raise his own seedlings, of which 72,600 are required to set 60 acres at the rate of 1,210 trees to the acre (6 by 6 feet).

INITIAL OUTLAY PER ACRE.

Value of land.....	\$4.00
Expense incurred for seed, labor, and construction of bed and shade, including cost of transplanting to nursery.....	2.42
Cost of planting.....	2.42
Taxes, at 2 per cent, for forty years.....	3.20
Total outlay.....	12.04

RETURNS.

Forty cords sold at \$4 on the stump brings \$160. Deducting \$12.04, we have a net value of \$147.96. Allowing 4 per cent compound interest, and taking total of taxes for each five years, then reckoning on the average time, the result per acre is as follows:

	Amount expended.	Amount at 4 per cent compound interest.
Land and seedlings in seed bed	\$5.21	\$25.01
Transplanting	1.21	5.81
Planting in permanent site	2.42	11.62
Taxes:		
First to fifth year .....	.40	1.92
Sixth to tenth year.....	.40	1.58
Eleventh to fifteenth year .....	.40	1.30
Sixteenth to twentieth year .....	.40	1.07
Twenty-first to twenty-fifth year .....	.40	.88
Twenty-sixth to thirtieth year.....	.40	.72
Thirty-first to thirty-fifth year.....	.40	.59
Thirty-sixth to fortieth year.....	.40	.49
Total.....	12.04	50.99

Deducting \$50.99 from \$160, there is a net profit of \$109.01, or a net annual return of \$1.15 per acre, paid at the expiration of forty years, in addition to 4 per cent compound interest on the money invested.



